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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/732,177	12/07/2000	Kenichi Hasegawa	116-002064	1420

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EXAMINER	
SHARON, AYAL I	

ART UNIT	PAPER NUMBER
2123	

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No. 09/732,177	Applicant(s) HASEGAWA, KENICHI	
	Examiner Ayal I. Sharon	Art Unit 2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 October 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-21* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☒ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Introduction

1. Claims 1-12 of U.S. Application 09/732,177 originally filed on 12/07/2000 are currently pending.
2. Claim 1 has been amended, thereby necessitating a new grounds of rejection for claim 1 and its dependent claims. This action is final.

Priority

3. Acknowledgment is made of applicant's claim for foreign priority based on an application filed in Japan on 12/07/1999. It is noted, however, that applicant has not filed a certified copy of the Japanese application as required by 35 U.S.C. 119(b).

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

   A person shall be entitled to a patent unless –

   (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. The prior art used for these rejections is as follows:

6. Morich, M. U.S. Patent 5,296,810. Date of Patent: March 22, 1994. (Henceforth "**Morich**").

7. The claim rejections are hereby summarized for Applicant's convenience. The detailed rejections follow.

8. **Claims 7, 10 and 12 are rejected under 35 U.S.C. 102(b) as being anticipated by Morich.**

9. In regards to claim 7, Morich teaches the following: 7. A magnetic field gradient coil assembly having wound inner and outer coils, said magnetic field gradient coil assembly having been designed by a method comprising the steps of:

(See Morich, especially: col.1, line 65 to col.2, line 10)

> setting or resetting the number of said inner coils and the number of turns of each inner coil and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions;

(See Morich, especially: Fig.7, Item 100 and associated text at col.7, lines 17-29)

> setting the number of said outer coils and the number of turns of each outer coil;

(See Morich, especially: Fig.7, Item 110 and associated text at col.7, lines 29-41)

> calculating Fourier components of an electric current spatial distribution necessary for the outer coils;

(See Morich, especially: Fig.7, Item 120; and col.7, line 41 to col.8, line 2; and col.8, line 51 to col.9, line 32)

> optimizing positions of the outer coils to approximate the Fourier components of the current distribution;

(See Morich, especially: Fig.7, Item 124 and associated text at col.8, lines 3-12)

> calculating magnetic fields leaking from the inner and outer coils, respectively;

(See Morich, especially: Fig.7, Item 130 and associated text at col.8, lines 34-50)

> resetting the number of the outer coils and the number of turns of each outer coil such that the magnetic field distortions caused by eddy currents fall within a tolerable range.

(See Morich, especially: Fig.7, Item 132 and associated text at col.8, lines 38-50; and col.12, Eq.28, where "... the j>1 derivatives represent contaminants.")

10. In regards to claim 10, Morich teaches the following:

> 10. The magnetic field gradient coil assembly of claim 7, wherein said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution performs the approximation using a small number of tightly wound coils.

(See Morich, especially: Fig.7, Item 110 and associated text at col.7, lines 29-41)

11. In regards to claim 12, Morich teaches the following:12. The magnetic field gradient coil assembly of claim 7, wherein said step of resetting the number of the outer coils and the number of turns of each outer coil if the magnetic field distortions are outside the tolerable range,

> said step of calculating Fourier components of an electric current distribution necessary for the outer coils,

(See Morich, especially: Fig.7, Item 120; and col.7, line 41 to col.8, line 2; and col.8, line 51 to col.9, line 32)

> said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution,

(See Morich, especially: Fig.7, Item 124 and associated text at col.8, lines 3-12)

> said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and

(See Morich, especially: Fig.7, Item 130 and associated text at col.8, lines 34-50)

> said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields are repeatedly carried out to determine optimum conditions for the outer coils by trial and error.

(See Morich, especially: Fig.7, Item 134 and associated text at col.8, lines 45-50)

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. The prior art used for these rejections is as follows:

14. Morich, M. U.S. Patent 5,296,810. Date of Patent: March 22, 1994. (Henceforth "**Morich**").

15. Jin, Jian-Ming. "Electromagnetics in Magnetic Resonance Imaging." IEEE Antennas and Propagation Magazine. Dec. 1996. Vol.40, Issue 6, pp.7-22. (Henceforth "**Jin**").

16. Weisstein, Eric. "Green's Function", from MathWorld – A Wolfram Web Resource. © 1999 CRC Press. (Henceforth "**MathWorld**").

17. The claim rejections are hereby summarized for Applicant's convenience. The detailed rejections follow.

18. **Claims 1, 4, and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Morich in view of Jin.**

19. In regards to claim 1, Morich teaches the following: 1. A method of designing a magnetic field gradient coil assembly using tightly wound inner and outer coils, said method comprising the steps of:

(See Morich, especially: col.1, line 65 to col.2, line 10)

> setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions;

(See Morich, especially: Fig.7, Item 100 and associated text at col.7, lines 17-29)

> setting or resetting the number of said outer coils and the number of turns of each outer coil;

(See Morich, especially: Fig.7, Item 110 and associated text at col.7, lines 29-41)

> calculating Fourier components of an electric current spatial distribution necessary for the outer coils;

(See Morich, especially: Fig.7, Item 120; and col.7, line 41 to col.8, line 2; and col.8, line 51 to col.9, line 32)

> optimizing positions of the outer coils to approximate the Fourier components of the current distribution;

(See Morich, especially: Fig.7, Item 124 and associated text at col.8, lines 3-12)

> calculating magnetic fields leaking from the inner and outer coils, respectively;

(See Morich, especially: Fig.7, Item 130 and associated text at col.8, lines 34-50)

However, Morich does not expressly teach the following limitations:

> calculating magnetic field distortions caused by eddy currents <u>at the outside of said outer coil</u> produced by the leaking magnetic fields; and
>
> resetting the number of the outer coils and the number of turns of each outer coil such that the magnetic field distortions caused by eddy currents fall within a tolerable range.

Jin, on the other hand, expressly identifies the claimed problem (See Jin, p.12, "4.4 Shielded Gradient Coils", 1st para. Emphasis added):

> One of the major problems in the use of switched gradient coils is the interaction of the rapidly switched fields with other conducting structures in an MRI system. The magnetic field produced by a gradient coil induces <u>eddy currents</u> in other conducting structures, which produce fields opposing that of the gradient coil. As a result, the gradient homogeneity can be degraded, and the rise and decay times of the switched field can be increased.

Jin also teaches the solution to the problem (See Jin, p.12, "4.4 Shielded Gradient Coils", 3rd para. Emphasis added):

> Basically, the shield coil produces a field that cancels that of the primary coil, <u>outside the shield coil</u>. As a result, the total field is zero <u>outside the gradient coil</u>. This technique is referred to as <u>active shielding</u>.

Jin also expressly teaches (See Jin, p.13, left column, 2nd para.):

> Figure 11 shows the current distribution on the primary and shield coils of a shielded longitudinal transverse-gradient coil. Shielded longitudinal-gradient coils can be designed in a similar manner.

Examiner interprets that the "Axial Distance" parameter is used to calculate the distance between the turns of each outer coil, from which the number of turns can be derived.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Morich with those of Jin, because doing so would minimize the noise generated by electromagnetic leaks.

20. In regards to claim 4, Morich teaches the following:

> 4. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution performs the approximation using a small number of tightly wound coils.

(See Morich, especially: Fig.7, Item 110 and associated text at col.7, lines 29-41)

21. In regards to claim 6, Morich teaches the following:6. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of resetting the number of the outer coils and the number of turns of each outer coil if the magnetic field distortions are outside the tolerable range,

> said step of calculating Fourier components of an electric current distribution necessary for the outer coils,

(See Morich, especially: Fig.7, Item 120; and col.7, line 41 to col.8, line 2; and col.8, line 51 to col.9, line 32)

> said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution,

(See Morich, especially: Fig.7, Item 124 and associated text at col.8, lines 3-12)

> said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and

(See Morich, especially: Fig.7, Item 130 and associated text at col.8, lines 34-50)

> said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields are repeatedly carried out to determine optimum conditions for the outer coils by trial and error.

(See Morich, especially: Fig.7, Item 134 and associated text at col.8, lines 45-50)

22. Claims 2, 3, and 5, are rejected under 35 U.S.C. 103(a) as being unpatentable over Morich in view of Jin and further in view of MathWorld.

23. In regards to claim 2, while Morich teaches the use of Fourier transforms (see col.11, lines 50-52; and col.12, lines 25-29; and col.7, lines 63-66), Morich does not expressly teaches the use of Green's function, as claimed:

> 2. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions uses a Green function.

MathWorld, on the other hand, expressly teaches that "A Green's function is an integral kernel that can be used to solve an inhomogeneous differential equation with boundary conditions. It serves roughly an analogous role in partial differential equations as does Fourier analysis in the solution of ordinary differential equations."

It therefore would have been obvious to one of ordinary skill in the art at the time the invention was made to use a Green's Function instead of Fourier analysis, because MathWorld teaches that "... It serves roughly an analogous role."

24. In regards to claim 3, while Morich teaches the use of Fourier transforms (see col.11, lines 50-52; and col.12, lines 25-29; and col.7, lines 63-66), Morich does not expressly teaches the use of Green's function, as claimed:

> 3. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of calculating Fourier components of an electric current distribution necessary for the outer coils uses a Green function.

MathWorld, on the other hand, expressly teaches that "A Green's function is an integral kernel that can be used to solve an inhomogeneous differential

equation with boundary conditions. It serves roughly an analogous role in partial differential equations as does Fourier analysis in the solution of ordinary differential equations."

It therefore would have been obvious to one of ordinary skill in the art at the time the invention was made to use a Green's Function instead of Fourier analysis, because MathWorld teaches that "... It serves roughly an analogous role."

25. In regards to claim 5, while Morich teaches the use of Fourier transforms (see col.11, lines 50-52; and col.12, lines 25-29; and col.7, lines 63-66), Morich does not expressly teaches the use of Green's function, as claimed:

> 5. A method of designing a magnetic field gradient coil assembly as set forth in claim 1,
>
> wherein said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and
>
> said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields use a Green function.

MathWorld, on the other hand, expressly teaches that "A Green's function is an integral kernel that can be used to solve an inhomogeneous differential equation with boundary conditions. It serves roughly an analogous role in partial differential equations as does Fourier analysis in the solution of ordinary differential equations."

It therefore would have been obvious to one of ordinary skill in the art at the time the invention was made to use a Green's Function instead of Fourier analysis, because MathWorld teaches that "... It serves roughly an analogous role."

26. Claims 8, 9 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Morich in view of MathWorld.

27. In regards to claim 8, while Morich teaches the use of Fourier transforms (see col.11, lines 50-52; and col.12, lines 25-29; and col.7, lines 63-66), Morich does not expressly teaches the use of Green's function, as claimed:

> Claim 8 (Previously Presented): The magnetic field gradient coil assembly of claim 7, wherein said step of setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions uses a Green's function.

MathWorld, on the other hand, expressly teaches that "A Green's function is an integral kernel that can be used to solve an inhomogeneous differential equation with boundary conditions. It serves roughly an analogous role in partial differential equations as does Fourier analysis in the solution of ordinary differential equations."

It therefore would have been obvious to one of ordinary skill in the art at the time the invention was made to use a Green's Function instead of Fourier analysis, because MathWorld teaches that "... It serves roughly an analogous role."

28. In regards to claim 9, while Morich teaches the use of Fourier transforms (see col.11, lines 50-52; and col.12, lines 25-29; and col.7, lines 63-66), Morich does not expressly teaches the use of Green's function, as claimed:

> Claim 9 (Previously Presented): The magnetic field gradient coil assembly of claim 7, wherein said step of calculating Fourier components of an electric current distribution necessary for the outer coils uses a Green's function.

MathWorld, on the other hand, expressly teaches that "A Green's function is an integral kernel that can be used to solve an inhomogeneous differential equation with boundary conditions. It serves roughly an analogous role in partial differential equations as does Fourier analysis in the solution of ordinary differential equations."

It therefore would have been obvious to one of ordinary skill in the art at the time the invention was made to use a Green's Function instead of Fourier analysis, because MathWorld teaches that "... It serves roughly an analogous role."

29. In regards to claim 11, while Morich teaches the use of Fourier transforms (see col.11, lines 50-52; and col.12, lines 25-29; and col.7, lines 63-66), Morich does not expressly teaches the use of Green's function, as claimed:

> Claim 11 (Previously Presented): The magnetic field gradient coil assembly of claim 7, wherein said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields uses a Green's function.

MathWorld, on the other hand, expressly teaches that "A Green's function is an integral kernel that can be used to solve an inhomogeneous differential equation with boundary conditions. It serves roughly an analogous role in partial differential equations as does Fourier analysis in the solution of ordinary differential equations."

It therefore would have been obvious to one of ordinary skill in the art at the time the invention was made to use a Green's Function instead of Fourier

analysis, because MathWorld teaches that "... It serves roughly an analogous role."

Conclusion

30. The following prior art, made of record and not relied upon, is considered pertinent to applicant's disclosure.

- Siebold, H. "Design Optimization of Main, Gradient and RF Field Coils for MR Imaging." <u>IEEE Transactions on Magnetics</u>. March 1990. Vol.26, Issue 2, pp.841-846. (Teaches on p.844, "Eddy Currents" section, 1st para.:

  > the gradient coils produce also a magnetic stray field outside the cylinder which induces eddy currents in the inner cryogenic radiation shields of the s.c. magnet ...

  Siebold also expressly teaches on p.845, "Passively Shielded Gradients" section, 1st para.:

  > "It is therefore necessary to design the gradient coils taking the eddy currents into account."

- U.S. Patent 5,349,297. Issued Sept. 20, 1994 to DeMeester et al. (Teaches the following on col.1, line 64 to col.2, line 3:

  > More recently, self shielded gradients have been developed so as to eliminate eddy currents. A self shielded gradient consists of a set of primary x, y, and z coils and an additional set of x, y, and z-coils at a larger radius. The geometry of the coils is chosen such that when the coils are excited in the series, they have substantially <u>**no residual gradient field outside of the outer coils**</u>.

- U.S. Patent 6,456,076 to Joseph. (Post-dates the instant application. Teaches the use of a shielding coil to cancel eddy currents.)

- U.S. Patent 5,488,299 to Kondo et al. (See abstract. Teaches the use of an active shield to eliminate eddy currents.)
- U.S. Patent 5,585,724 to Morich et al. (Teaches the use of a "second or shield gradient coil " to eliminate eddy currents. See col.12, lines 35-50).
- U.S. Patent 6,100,692 to Petropoulos et al. (Teaches a method of designing shielded gradient coil assemblies and eddy current analysis. See col.3, lines 2-20).

31. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Correspondence Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ayal I. Sharon whose telephone number is (571) 272-3714. The examiner can normally be reached on Monday through Thursday, and the first Friday of a biweek, 8:30 am – 5:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Leo Picard can be reached at (571) 272-3749.

Any response to this office action should be faxed to (571) 273- 8300, or mailed to:

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or hand carried to:

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Randolph Building
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Alexandria, VA 22314

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Tech Center 2100 Receptionist, whose telephone number is (571) 272-2100.

Paul L. Rodriguez 12/16/05
Primary Examiner
Art Unit 2125

Ayal I. Sharon
Art Unit 2123
December 16, 2005